Missouri Department of Natural Resources

Biological Assessment Report

Flat Creek
Pettis County

December 14, 2005

Prepared for:

Missouri Department of Natural Resources
Division of Environmental Quality
Water Protection Program
Water Pollution Branch

Prepared by:

Missouri Department of Natural Resources
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1.0 Introduction

At the request of the Water Protection Program (**WPP**), the Environmental Services Program's (**ESP**) Water Quality Monitoring Section (**WQMS**) conducted a biological assessment of Flat Creek, which flows through mostly rural portions of Pettis County, Missouri. A total of 20 miles of Flat Creek, draining approximately 203 square miles of watershed, was added to the 303(d) list of impaired waters in 1998 due to probable impacts from sediment resulting from agricultural non-point source pollution.

Sampling at Flat Creek was conducted on September 27-28, 2004 and on March 28-29, 2005 to provide data to the WPP for use in evaluating and comparing the biological integrity of the stream. Dave Michaelson and Ken Lister of the Environmental Services Program, Field Services Division conducted the sampling.

The goal of this study was to test the following three null hypotheses:

1) Macroinvertebrate assemblages will not differ among reaches of Flat Creek from upstream to downstream;

2) Water chemistry will not differ among reaches of Flat Creek from upstream to downstream;

3) The macroinvertebrate assemblage of Flat Creek will not differ from that found in biological criteria reference streams.

2.0 Study Area

The mainstem of Flat Creek is approximately 52 miles long and originates in northern Benton County, west of the town of Ionia, Missouri. It flows northeast toward Sedalia, then continues eastward to its confluence with Richland Creek to form the Lamine River south of Otterville, Missouri. The approximately 420 square mile watershed is mostly rural, dominated by pasture, cropland, and woodlands. See Table 1 for a comparison of land use for Flat Creek, the Plains/Missouri Tributaries between the Blue and Lamine Rivers Ecological Drainage Unit (**EDU**), and the biocriteria reference streams used in this study.

Flat Creek is located in the Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU. An EDU is a region in which aquatic biological communities and habitat conditions can be expected to be similar. Please see Appendix A for a display of the EDU and the 11-digit Hydrologic Unit (**HU**), 10300103010, which represents the Flat Creek watershed. Each of the Flat Creek sampling stations fall in a reach designated class "P" with beneficial use designations of "livestock and wildlife watering" and "protection of warm water aquatic life and human health--fish consumption."

Table 1
Percent Land Cover

	Urban	Crops	Grassland	Forest
PMBL EDU*	2.2	41.1	38.2	16.3
Flat Creek**	<1.0	26.0	51.0	20.0
Richland Creek	0.1	67.1	22.3	8.5
Heaths Creek	1.3	13.9	62.7	19.7
Moniteau Creek	0.2	16.2	62.4	20.0
Boeuf Creek #1	0.7	19.2	45.7	33.6
Boeuf Creek #2	0.6	9.2	28.4	61.1
Burris Fork	0.5	12.7	68.0	18.0
Loutre River	1.3	29.9	24.8	42.6

*Plains/Missouri Tributaries between the Blue and Lamine Rivers Ecological Drainage Unit
**Includes entire watershed--i.e. Flat Creek and each of its sub-watersheds

3.0 Site Descriptions

All Flat Creek sample stations were located in Pettis County, Missouri. The average width and discharge measurements during the survey period are given for each sampling station in Table 2 in the Data Results section.

Flat Creek #1 (NE ¼ sec. 24, T. 45 N., R. 21 W.) was located downstream of the State Road M bridge. This site was bordered on both sides by crop fields, with a portion of the left descending bank being nearly devoid of riparian cover such that crops are planted up to the edge of the creek bank. Geographic coordinates at the upstream terminus of this location were Lat. 38.663281º, Long. -93.179520º.

Flat Creek #2 (SW ¼ sec. 21, T. 45 N., R. 21 W.) was located downstream of the South Grand Street bridge. The sample reach had good riparian cover along both banks. Much of the stream bottom was bedrock and the banks were armored with rock bluffs as well as cobble- and boulder-sized rock. Geographic coordinates at the upstream terminus of this location were Lat. 38.656355º, Long. -93.239774º.

Flat Creek #3 (NW ¼ sec. 1, T. 44 N., R. 22 W.) was located downstream of the Morgan Road bridge. The sample reach was located downstream of the Basin Fork confluence. Basin Fork is the receiving system for a three-cell lagoon located in Green Ridge (Permit #MO0049654, Design Flow = 0.068 million gallons/day). A good riparian corridor was present and the stream banks were stable. The adjacent property owner spoke of a recurrent sheen, which she attributed to a pipeline that crosses Flat Creek just downstream from Morgan Road. MDNR Environmental Emergency Response Incident Number 960417-0953-EJS noted a report of an unknown yellow liquid leaking from Phillips Pipeline at this site in April 1996. The MDNR investigator assigned this incident, however, did not observe anything resembling the reported liquid and no further

incidents have been reported at this site. Geographic coordinates at the upstream terminus of this location were Lat. 38.626266º, Long. -93.301056º.

Flat Creek #4 (SW ¼ sec. 29, T. 44 N., R. 22 W.) was located downstream of the Bennett Road bridge. Relative to the downstream sites, the creek at this point is considerably smaller, with lower flows. As a result, riffle areas are smaller and have less wetted area. The riparian corridor was good on both sides, providing a buffer between the stream and crop fields on the left descending bank and a cleared section of forest on the right. Geographic coordinates at the upstream terminus of this location were Lat. 38.555111º, Long. -93.376011º.

Flat Creek #5 (SW ¼, SW ¼ sec. 36, T. 44 N., R. 23 W.) was downstream of the Highway 52 bridge. The stream at this site is also small, with good riparian corridor separating much of the sample reach from a crop field along the left descending bank. Near the end of the sample reach, the riparian corridor dwindles to nothing along the left bank. The landowner of the right bank indicated that poultry litter had been applied to the field adjacent to the left bank prior to our spring sampling. In addition, the landowner upstream from the sample site (upstream of Highway 52) had a small cattle feed lot which drains into Flat Creek. Geographic coordinates at the upstream terminus of this location were Lat. 38.539821º, Long. -93.417770º.

4.0 Methods

4.1 Macroinvertebrate Collection and Analyses

A standardized sample collection procedure was followed as described in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**) (MDNR 2003b). Three standard habitats--depositional substrate in non-flowing water, rootmat at the stream edge, and flowing water over coarse substrate--were sampled at all locations.

A standardized sample analysis procedure was followed as described in the SMSBPP. The following four metrics were used: 1) Taxa Richness (**TR**); 2) total number of taxa in the orders Ephemeroptera, Plecoptera, and Trichoptera (**EPTT**); 3) Biotic Index (**BI**); and 4) Shannon Diversity Index (**SDI**). These metrics are scored and combined to form the Stream Condition Index (**SCI**). Stream Condition Indices between 20-16 qualify as biologically supporting, between 14-10 are partially supporting, and 8-4 are considered non-supporting of aquatic life. The multi-habitat macroinvertebrate data are presented in Appendix D as laboratory bench sheets.

Additionally, macroinvertebrate data were analyzed to make comparisons among longitudinal reaches. This comparison addresses influences that may result from influxes from such sources as stormwater, wastewater, and tributaries. Data are summarized and presented in tabular format comparing means of the four standard metrics and other parameters at each of the stations on Flat Creek. Finally, the data from Flat Creek were

compared to biological criteria from reference streams within the same watershed size classification and within the same (and an adjacent) EDU. Biological criteria data collected from previous survey years constituted the basis of the comparison.

4.2 Physicochemical Data Collection and Analysis

During each survey period, *in situ* water quality measurements were collected at all stations. Field measurements included temperature (ºC), dissolved oxygen (mg/L), conductivity (µS/cm), turbidity (NTU), and pH. Additionally, water samples were collected and analyzed by ESP's Chemical Analysis Section for chloride, total phosphorus, ammonia-N, nitrate+nitrite-N, and total Kjeldahl nitrogen (**TKN**) (all parameters reported in mg/L). Procedures outlined in Field Sheet and Chain of Custody Record (MDNR 2001) and Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations (MDNR 2003d) were followed when collecting water quality samples. Stream velocity was measured at each station during the survey period using a Marsh-McBirney Flo-Mate™ Model 2000. Discharge was calculated per the methods in the Standard Operating Procedure MDNR-FSS-113, Flow Measurement in Open Channels (MDNR 2003a). Physicochemical data were summarized and presented in tabular form for comparison among stations on Flat Creek.

Stream habitat characteristics for each sampling station were measured during the fall 2004 survey period using a standardized assessment procedure as described for riffle/pool habitat in the Stream Habitat Assessment Project Procedure (MDNR 2003c).

4.3 Quality Assurance/Quality Control (QA/QC)

QA/QC procedures were followed as described in the SMSBPP and in accordance with the Fiscal Year 2004 Quality Assurance Project Plan for "Biological Assessment."

5.0 Data Results

5.1 Physicochemical Data

Physical characteristics of Flat Creek sample stations are presented in Table 2. Average stream widths at Flat Creek ranged from 41 to 114 feet, with widths increasing in downstream stations. Stream flow was highest at the two downstream stations, whereas the two upstream stations had little or no measurable flow during both sample seasons.

In situ water quality measurements are summarized in Table 3 and Table 4. Temperature readings varied seasonally, with mean temperatures higher in the fall (19.3ºC) than in the spring (11.7ºC). Temperatures among Flat Creek sites were stable during the fall season, varying by no more than 3.0ºC. During the spring season, however, a considerable difference was observed, with water temperature at Station 5 (15.5ºC) being nearly twice as high as Station 1 (8.0ºC).

Table 2
Physical Characteristics of the Flat Creek Sample Stations

Station	Avg. Width (ft.)	Fall 2004 Flow (cfs)	Spring 2005 Flow (cfs)
1	114	4.2	19.6
2	88	3.1	19.7
3	86	1.0	7.5
4	53	0.1	0.8
5	41	<0.1	0.2

Table 3
Fall 2004 *In situ* Flat Creek Water Quality Measurements

	Parameter				
Station	Temperature (ºC)	Dissolved O_2 (mg/L)	Conductivity (µS/cm)	pH	Turbidity (NTU)
1	19.0	5.77	242	7.37	14.1
2	21.0	6.54	292	7.50	8.82
3	18.0	6.87	280	7.28	5.16
4	19.5	6.60	209	7.68	9.12
5	19.0	4.51	185	7.71	12.0

Table 4
Spring 2005 *In situ* Flat Creek Water Quality Measurements

	Parameter				
Station	Temperature (ºC)	Dissolved O_2 (mg/L)	Conductivity (µS/cm)	pH	Turbidity (NTU)
1	8.0	12.6	365	8.20	5.06
2	10.0	10.8	405	7.80	8.20
3	11.0	10.8	396	8.10	4.50
4	14.0	11.0	474	8.10	3.65
5	15.5	13.1	503	8.30	4.80

Turbidity readings of fall samples were slightly higher than spring samples at all stations. Turbidity at Station 2 and Station 3 exhibited the smallest variation, with differences of less than 1 NTU observed between seasons. Fall turbidity readings among the remaining stations were between two and three times higher than readings observed in spring samples.

Compared to the fall 2004 season, pH readings were slightly higher at Flat Creek stations during the spring 2005 season. These differences were small, however, with extremes between seasons varying by 1.02 units. Within season pH readings varied by no more than 0.5 units.

Conductivity readings also were higher during the spring sample season at all stations. This difference was especially prominent at Station 5, which experienced a nearly three-fold increase in spring compared to the previous fall. When compared to other spring conductivity readings, however, Station 5 was only slightly elevated. Conductivity readings among stations did not exhibit any patterns relative to their position in the watershed, despite possible wastewater input. Water chemistry grab samples were collected at Station 3 downstream from Basin Fork, the receiving system for one MDNR-permitted wastewater treatment facility and possibly from a small trailer park several hundred meters upstream from the Flat Creek confluence. In spring 2005 conductivity readings were recorded from Basin Fork and Flat Creek upstream of Basin Fork, in addition to Flat Creek Station 3. Conductivity readings were higher in Basin Fork (450 µS/cm) than in Flat Creek upstream of the confluence (389 µS/cm). Basin Fork appears to have increased the Flat Creek conductivity only slightly, from 389 to 396 µS/cm. Given the amount of variability among conductivity readings at the other Flat Creek stations (and the fact that conductivity at Stations 4 and 5 were much higher than at Station 3), this change is likely insignificant.

Although dissolved oxygen concentrations were much lower during the fall season, only Station 5 had levels that were below the 5 mg/L minimum concentration listed in the Missouri Water Quality Standards for protection of aquatic life (warmwater and coolwater fisheries). During the spring season, dissolved oxygen concentrations were much higher, with most levels being at least twice as high as the minimum standard.

Nutrient as well as chloride concentrations are presented in Table 5 (fall 2004) and Table 6 (spring 2005). Nutrient concentrations varied mostly by season, with all nutrients except nitrogen as ammonia being higher in fall samples. Nitrogen as ammonia concentrations were below detectable levels at all sites during both sample seasons. In contrast to the nutrient parameters, which all were higher in fall samples, chloride levels were higher among all sites during the spring season. Nutrient parameters and chloride did not exhibit any patterns relative to their position in the watershed, despite influxes from numerous tributaries along the survey reach. These parameters either were very similar among sites or they displayed a high degree of variability among sites with no longitudinal pattern.

Table 5
Fall 2004 Flat Creek Nutrient Concentrations

	Parameter (mg/L)				
Station	NH_3-N	NO_3+NO_2-N	TKN	Total Phosphorus	Chloride
1	0.03*	0.22	1.26	0.34	13.1
2	0.03*	0.08	0.96	0.25	13.3
3	0.03*	0.05	0.88	0.25	12.1
4	0.03*	0.10	1.20	0.44	9.89
5	0.03*	0.09	1.32	0.50	10.5

*Below detectable levels

Table 6
Spring 2005 Flat Creek Nutrient Concentrations

	Parameter (mg/L)				
Station	NH_3-N	NO_3+NO_2-N	TKN	Total Phosphorus	Chloride
1	0.03*	0.02	0.29	0.04	16.5
2	0.03*	0.01*	0.45	0.05	15.0
3	0.03*	0.02	0.46	0.04	15.2
4	0.03*	0.01*	0.47	0.04	16.4
5	0.03*	0.01*	0.52	0.06	18.6

*Below detectable levels

5.2 Habitat Assessment

Habitat assessment scores were recorded for each sampling station. Results are presented in Table 7. According to the project procedure, for a study site to fully support a biological community, the total score from the physical habitat assessment should be 75% to 100% similar to the total score of a reference site. The habitat score for Heaths Creek, the biocriteria reference stream used for comparison, was 131. The mean habitat score among Flat Creek sites was 126. Because all Flat Creek stations had habitat scores that exceeded or were within the required range of similarity, it was inferred that the sites should support comparable biological communities.

Table 7
Reference Streams and Flat Creek Habitat Assessment Scores

Reference Stream	Habitat Score	Flat Creek Sample Stations	Habitat Score	% of Mean Reference
Heaths Creek	131	1	110	84
		2	126	96
		3	141	108
		4	125	95
		5	129	98

5.3 Biological Assessment

5.3.1 Flat Creek Longitudinal Comparison

Metrics calculated for Flat Creek were compared to biological criteria based on reference sites from the Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU and the Ozark/Moreau/Loutre EDU. These criteria for fall and spring sample seasons, presented in Tables 8 and 9, were used to assess the overall health of the aquatic community relative to reference communities within these EDUs.

Table 8
Biological Criteria for Warm Water Reference Streams in the Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU, Fall Season

	Score = 5	Score = 3	Score = 1
TR	>68	68-34	<34
EPTT	>13	13-6	<6
BI	<7.05	7.05-8.52	>8.52
SDI	>3.08	3.08-1.54	<1.54

Table 9
Biological Criteria for Warm Water Reference Streams in the Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU, Spring Season

	Score = 5	Score = 3	Score = 1
TR	>71	71-36	<36
EPTT	>13	13-6	<6
BI	<6.45	6.45-8.22	>8.22
SDI	>2.80	2.80-1.40	<1.40

Biological metrics for fall 2004 samples varied widely among Flat Creek sites (Table 10). Although the highest Taxa Richness value of 82 occurred at Station 1, the number of taxa did not steadily decrease in subsequent upstream stations. For example, the next highest Taxa Richness value occurred at Station 5, the uppermost site. The number of EPT Taxa was highest at Station 2, whereas the remaining stations exhibited scores comparable to one another. Although the Biotic Index values exhibited some variability, it was insufficient to result in any difference among Biotic Index scores among sites. The Shannon Diversity Index was highest at Station 1, with the remaining stations having values relatively close to one another.

Table 10
Flat Creek Metric Values and Scores, Fall 2004 Season, Using Plains/Missouri Tributaries between the Blue and Lamine Rivers Biological Criteria Reference Database

Site	TR	EPTT	BI	SDI	SCI	Support
#1 Value	82	12	6.22	3.14		
#1 Score	5	3	5	5	18	**Full**
#2 Value	69	17	6.61	2.99		
#2 Score	5	5	5	3	18	**Full**
#3 Value	68	11	6.54	2.95		
#3 Score	3	3	5	3	14	**Partial**
#4 Value	62	10	6.82	2.98		
#4 Score	3	3	5	3	14	**Partial**
#5 Value	70	10	7.03	2.80		
#5 Score	5	3	5	3	16	**Full**

During the spring 2005 sample season, stations higher in the watershed (Stations 3-5) tended to score lower compared to downstream stations (Stations 1 and 2) (Table 11). Although Taxa Richness values were variable, ranging from 57 to 69, Taxa Richness scores were identical among sites and did not contribute to differences observed in Stream Condition Index scores. Stations 1 and 2 were the only sites to achieve the top score for EPTT and Biotic Index. These two indices were, numerically speaking, the resulting factor in Stations 1 and 2 attaining fully biologically supporting status. Shannon Diversity Index values were similar among sites, with each station achieving the highest available score.

Table 11
Flat Creek Metric Values and Scores, Spring 2005 Season, Using Plains/Missouri Tributaries between the Blue and Lamine Rivers Biological Criteria Reference Database

Site	TR	EPTT	BI	SDI	SCI	Support
#1 Value	69	14	5.81	3.12		
#1 Score	3	5	5	5	18	**Full**
#2 Value	65	16	6.30	3.06		
#2 Score	3	5	5	5	18	**Full**
#3 Value	57	10	6.52	3.09		
#3 Score	3	3	3	5	14	**Partial**
#4 Value	67	10	6.80	3.13		
#4 Score	3	3	3	5	14	**Partial**
#5 Value	58	7	6.97	2.96		
#5 Score	3	3	3	5	14	**Partial**

5.3.2 **Macroinvertebrate Percent and Community Composition**

Macroinvertebrate Taxa Richness, EPT Taxa, and percent EPT are presented in Table 12 and Table 13. These tables also provide percent composition data for the five dominant macroinvertebrate families at each Flat Creek station. The percent relative abundance data were averaged from the sum of three macroinvertebrate habitats--coarse substrate, nonflow, and rootmat--sampled at each station.

Fall 2004 macroinvertebrate samples from Flat Creek averaged 70 total taxa (range 62-82) and 12 EPT Taxa (range 10-17). Midge larvae (Chironomidae) were the dominant taxa at all sites except Station 3, where they were second in abundance, and Station 5, where they ranked third. Chironomids were the only group to be present among the top five taxa at all sites. Baetid mayflies were among the dominant taxa at only two sites, but were the most abundant at Station 3 and second in abundance at Station 1. Within the family Baetidae, two genera (*Baetis* and *Acerpenna*) made up nearly 86 percent of mayfly taxa at Station 1 and 55 percent at Station 3. The majority of individuals in these two taxa were found in coarse substrate habitat at Station 1 and were found exclusively in coarse substrate at Station 3. A second family of mayflies, Caenidae (composed only of

the species *Caenis latipennis*), was present in fairly high numbers in the lower four sample sites and was the dominant taxa group at Station 5. Caddisflies (Trichoptera) were similarly represented among all sites, with the exception of Station 5, which had less than half the abundance of caddisfly taxa compared to Station 1, the site with the next lowest abundance. A single genus, *Cheumatopsyche*, was the dominant caddisfly at all stations, making up between 73-96 percent of caddisfly taxa. A single stonefly (Plecoptera) individual of the genus *Isoperla* was present among all Flat Creek fall samples. Compared to spring samples, mollusks tended to be present in greater numbers and in slightly higher diversity in fall samples. In the fall, Station 1 had the greatest diversity with six mollusk taxa represented, but very few individuals of each. Station 5 had the second highest mollusk diversity in fall with five taxa, but had the highest number of individuals among samples for both seasons. Station 2, which had no mollusks in spring had only a single taxon (Sphaeriidae) in the fall.

Table 12
Fall 2004 Flat Creek Macroinvertebrate Composition

Variable-Station	1	2	3	4	5
Taxa Richness	82	69	68	62	70
Number EPT Taxa	12	17	11	10	10
% Ephemeroptera	22.7	23.4	36.9	21.6	35.4
% Plecoptera	--	<0.1	--	--	--
% Trichoptera	17.0	18.6	14.0	17.4	5.0
% Dominant Families					
Chironomidae	35.0	26.8	18.4	22.6	13.2
Baetidae	19.6	--	20.4	--	--
Hydropsychidae	12.5	18.1	12.7	14.6	--
Elmidae	5.3	11.4	--	12.8	18.7
Tubificidae	5.1	--	--	--	--
Hyalellidae	--	8.7	11.6	10.5	11.3
Heptageniidae	--	8.2	9.2	9.0	8.0
Caenidae	--	--	--	--	23.2

Spring 2005 macroinvertebrate samples averaged 63 total taxa (range 57-69) and 11 EPT Taxa (range 7-16). Chironomids were the dominant taxa at all stations, being at least three times more abundant than the next nearest family group. Riffle beetles (Elmidae) also were present among the dominant taxa at all stations. A single genus, *Stenelmis*, made up at least 94 percent of riffle beetles collected in samples. Compared to the fall samples, caddisflies were much less numerous with fewer than ten individuals present in samples at all stations. Stoneflies were much more abundant in spring samples and were more numerous in the three downstream stations. The genera *Perlesta* and *Isoperla* were the most abundant stoneflies at all stations and were the only genera present at Station 3 and Station 4. At Station 5, *Perlesta* was the only stonefly taxon present in samples. Aquatic worms (Tubificidae) were present among the dominant taxa at the upstream three stations during the spring season. In contrast, tubificids were only present among

dominant taxa at Station 1 during the fall sample season. Mollusks, including fingernail clams (Sphaeriidae) and aquatic snails, were relatively rare in spring samples. At three of the sites, Stations 1, 2, and 4, mollusks either were absent in samples (Station 2) or were represented by a single individual (Stations 1 and 4). Station 5, the uppermost site, had the greatest diversity and abundance of mollusks with four taxa and Station 3, with two taxa, had the second highest mollusk taxa diversity.

Table 13
Spring 2005 Flat Creek Macroinvertebrate Composition

Variable-Station	1	2	3	4	5
Taxa Richness	69	65	57	67	58
Number EPT Taxa	14	16	10	10	7
% Ephemeroptera	21.4	28.1	23.9	13.7	7.8
% Plecoptera	4.0	3.1	3.4	1.6	0.4
% Trichoptera	0.5	0.7	0.1	0.4	0.4
% Dominant Families					
Chironomidae	52.4	43.5	45.6	57.0	53.6
Baetidae	13.3	5.7	--	--	--
Elmidae	13.3	15.9	10.9	8.3	13.5
Heptageniidae	4.8	11.6	6.9	--	--
Perlidae	3.3	--	--	--	--
Caenidae	--	10.6	11.8	8.3	5.9
Tubificidae	--	--	8.1	6.5	9.9
Hyalellidae	--	--	--	8.0	6.1

5.3.3 Comparisons of Flat Creek versus Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU Biological Criteria Reference Sites

Macroinvertebrate data for six biocriteria reference streams sampled in fall between 1998 and 2001 are presented in Table 14 and spring samples collected between 1998 and 2001 are presented in Table 15. Taxa Richness averaged 74 (range 62-87) in fall and 77 (range 59-91) in spring samples. Total EPT Taxa averaged 15 (range 9-20) in fall and 16 (range 8-21) in spring samples.

The majority of Flat Creek fall 2004 macroinvertebrate metrics were comparable to those of the biological criteria reference sites. The lowest Taxa Richness value (62) was the same for both Flat Creek and the suite of reference samples. Mean Taxa Richness of Flat Creek (70) was very close to the mean of the reference sites (74). Flat Creek EPT Taxa values tended to be lower than most of the reference sites. With the exception of Station 2, which had 17 EPT Taxa, Flat Creek fall 2004 EPT Taxa values were considerably lower compared to the reference sites. Although there were fewer EPT Taxa among Flat Creek sites, mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) made up similar percentages of the total sample relative to reference sites.

Table 14
Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU Biocriteria Reference Stream Macroinvertebrate Composition, Fall Season

	Richland Ck	Heaths Creek			Moniteau Creek			Boeuf Creek		Burris Fk	Loutre R
Sample Year	2001	1998	2001		1998		2001	2001		1998	1999
Station-Variable	2	1	1	2	1	2	1	1	2	1	1
Taxa Richness	79	64	80	62	67	73	79	77	87	74	69
Number EPT	20	9	15	13	16	16	13	14	17	19	10
% Ephemeroptera	31.1	28.2	25.2	37.5	16.5	38.4	21.6	34.2	36.1	24.5	14.6
% Plecoptera	0.3	--	--	--	--	--	--	<0.1	--	--	--
% Trichoptera	8.9	10.8	17.4	11.8	20.8	3.6	6.3	6.0	6.0	13.8	2.0
% Dominant Families											
Chironomidae	26.2	39.6	27.5	10.2	32.2	44.6	22.4	34.7	23.5	47.2	44.6
Caenidae	18.7	--	12.3	22.3	--	11.6	7.0	21.0	13.1	9.1	11.8
Coenagrionidae	9.8	--	--	--	--	--	7.5	--	--	--	8.5
Heptageniidae	7.7	11.0	7.8	--	--	15.9	--	--	--	--	--
Arachnoidea	6.2	--	--	--	--	--	--	3.8	--	--	--
Elmidae	--	13.2	--	--	--	5.6	15.4	5.9	5.0	--	5.0
Baetidae	--	12.1	--	7.6	6.3	10.6	--	--	--	8.1	--
Hydropsychidae	--	6.7	17.1	11.3	6.4	--	--	--	--	5.2	--
Hyalellidae	--	--	6.4	26.4	--	--	--	--	7.5	--	--
Philopotamidae	--	--	--	--	12.7	--	--	--	--	8.3	--
Tubificidae	--	--	--	--	7.5	--	9.4	--	--	--	--
Leptohyphidae	--	--	--	--	--	--	--	11.9	17.4	--	--
Corixidae	--	--	--	--	--	--	--	--	--	--	7.3

Table 15
Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU Biocriteria Reference Stream Macroinvertebrate Composition, Spring Season

	Richland Ck		Heaths Creek			Moniteau Creek			Boeuf Creek		Burris Fk		Loutre R
Sample Year	2001		1998	2001		1998		2001	2001		1998	2001	1999
Station-Variable	1	2	1	1	2	1	2	1	1	2	1	1	1
Taxa Richness	71	59	74	65	78	75	75	69	71	91	87	92	89
Number EPT	13	13	13	8	13	15	17	13	19	20	18	19	21
% Ephemeroptera	5.3	5.0	39.5	20.0	30.1	21.9	23.0	10.5	38.2	45.6	37.8	14.8	35.8
% Plecoptera	20.4	16.3	17.1	9.3	12.9	13.8	19.4	15.0	9.0	8.1	9.1	5.4	5.4
% Trichoptera	0.6	0.6	0.3	0.4	1.2	1.7	0.9	0.9	3.0	4.7	1.1	1.1	0.9
% Dominant Families													
Chironomidae	52.9	58.0	16.9	30.0	21.2	31.2	10.8	33.3	35.2	23.9	17.4	29.4	39.8
Chloroperlidae	18.0	10.1	35.2	--	--	--	--	--	6.8	7.0	--	--	--
Caenidae	5.0	4.8	--	15.3	25.3	19.3	18.1	9.1	26.3	29.5	34.9	13.7	31.0
Simuliidae	4.0	9.3	--	--	--	--	--	--	--	--	--	--	--
Crangonyctidae	3.6	4.6	--	--	--	4.8	6.9	--	--	--	8.0	--	--
Asellidae	--	--	9.0	--	--	--	--	--	--	--	--	--	--
Perlodidae	--	--	7.5	9.0	12.3	6.5	12.1	14.1	--	--	--	4.5	--
Nemouridae	--	--	7.3	--	--	--	--	--	--	--	--	--	--
Elmidae	--	--	7.3	20.6	12.5	7.7	18.1	13.1	--	--	12.0	23.9	6.1
Tubificidae	--	--	--	5.6	9.9	--	--	10.2	--	--	4.1	--	--
Baetidae	--	--	--	--	--	--	--	--	8.3	--	--	--	--
Hyalellidae	--	--	--	--	--	--	--	--	4.5	--	--	8.2	--
Leptohyphidae	--	--	--	--	--	--	--	--	--	7.9	--	--	--
Arachnoidea	--	--	--	--	--	--	--	--	--	5.5	--	--	--
Heptageniidae	--	--	--	--	--	--	--	--	--	--	--	--	3.7
Perlidae	--	--	--	--	--	--	--	--	--	--	--	--	2.3

Despite the variation among mayfly percentages at the Flat Creek stations, all were reasonably similar to those of the reference streams. With the exception of Station 5, Flat Creek caddisfly percentages were comparable to some of the highest values among reference sites. Although Station 5 had the lowest caddisfly percentage among Flat Creek sites, it was comparable to the lower values observed among reference sites. A single stonefly individual was present among all Flat River fall samples, a trait shared among the biological references. Of the 11 reference samples spanning the three years that were used for comparison for this EDU, a total of five stonefly individuals were present. As was the case with all but one of the reference samples, chironomids were the dominant taxa group at most Flat Creek sites. Chironomid taxa were the most numerous taxa at three Flat Creek sites in fall 2004. In nearly all fall reference samples, squaregill mayflies (Caenidae) were among the dominant taxa. Although present in fairly high numbers in Flat Creek samples, caenid mayflies (specifically the species *Caenis latipennis*) were counted among the dominant taxa only at Station 5, where they were the dominant taxa group. Although the mayfly family Heptageniidae and the crustacean family Hyalellidae were occasionally present among the dominant taxa in reference streams, they were present in sufficient numbers at Flat Creek Stations 2 through Station 5 to be in the top five taxa in terms of abundance.

Flat Creek spring 2005 macroinvertebrate metrics generally were comparable to the lower values among biological criteria reference sites (Table 15). EPT Taxa values for Flat Creek Station 3 to Station 5 were lower than all but one reference sample, whereas the downstream two stations had EPT Taxa values closer to the mean among references. Flat Creek Taxa Richness values were similar to the lowest reference values, with those of Flat Creek Station 3 and Station 5 being slightly lower than even the lowest of the references. Mayflies made up a comparable percentage of samples among Flat Creek sites to the references. Although Flat Creek Stations 4 and 5 had a much lower percentage of mayflies compared to downstream stations in spring, there were even lower percentages observed among several of the reference samples. The degree to which stoneflies were present in Flat Creek spring samples, however, is very different from the reference sites. Whereas stonefly taxa made up a sizeable portion (>10%) of samples in references, none of the Flat Creek samples had in excess of 5% stoneflies. Stonefly taxa were among the top five dominant taxa in all but one sample from the biological criteria reference sites. By comparison, Flat Creek Station 1 was the only site to have stonefly taxa in sufficient quantities to rank among dominant taxa. Caddisfly taxa were relatively rare in Flat Creek spring samples, a trend similar among reference sites. Mayflies in the family Caenidae were among the dominant taxa in all but one of the reference samples. Other mayfly families (Baetidae and Heptageniidae) each were in the top five taxa at only a single site. Similarly, caenids were among the dominant taxa at all but Flat Creek Station 1; however baetids and heptageniids were relatively numerous at the lower three Flat Creek stations, unlike the reference sites, where these families each were dominant in a single sample. Although chironomids were the dominant family at most Flat Creek sites in fall samples, their numbers were typically twice as high in spring samples, resulting in chironomids being dominant at all sites in the spring. A similar trend existed

among references, with chironomid numbers being higher in spring samples, but at reference sites numbers of chironomids tended not to be as overwhelmingly dominant.

6.0 Discussion

Most non-nutrient water quality parameters varied little among Flat Creek stations in fall 2004. The exceptions--lower dissolved oxygen and conductivity at Station 5--were minor. During the spring 2005 season, however, there were a few notable differences among stations. Specifically, temperature and conductivity were higher and flow was much lower at the two upstream sites compared to those downstream. Increased temperatures at the upstream stations are likely due in part to these lower flow rates. Water tends to be retained in the fairly shallow pools longer at the upper stations as flushing rates are reduced, resulting in greater absorption and retention of heat from solar radiation. It was interesting that conductivity was higher at stations upstream from Station 3, the only upper site that has the possibility of wastewater influx. It is possible that land application of poultry litter and drainage from a cattle feed lot adjacent to such low flows in Flat Creek may have contributed to higher chloride concentrations and, consequently, to elevated conductivity readings observed at Station 5.

Despite the presence of possible contamination sources discussed above, none of the spring 2005 nutrient parameters showed any patterns relative to these sources. Nutrient concentrations actually were considerably lower in spring samples compared to fall. Though somewhat higher, fall 2004 nutrient levels were consistent among sites and did not show any patterns longitudinally or in relation to possible point sources. Habitat scores of the upper four sites of Flat Creek were similar to one another, with scores being comparable to or exceeding the reference site habitat score. Station 1 scored lower than the other sites, mainly due to poor riparian corridor and very little vegetative cover along a sizeable portion of the banks within this sample reach.

With the exception of Station 5 in the fall, Stream Condition Index scores tended to be lower in the upper sample reaches. These lower scores were the result of lower Taxa Richness and EPTT scores at sites that achieved a partially supporting rank. In the case of Station 3, a single additional taxon would have resulted in a fully supporting score. In the spring season, only Stations 1 and 2 achieved a fully supporting rank. In this instance, lower EPTT and Biotic Index scores were the factors that resulted in the overall difference in supportability. The upstream three stations had numbers of mayfly taxa comparable to Stations 1 and 2, but these stations had far fewer caddisfly taxa (fall season) and stonefly taxa (spring season) which resulted in the lower EPTT scores. Although there were fewer caddisfly taxa present in fall samples at Stations 4 and 5, the taxa that were present, *Cheumatopsyche* and *Chimarra*, were quite abundant. These two taxa also were the dominant caddisfly taxa among the remaining stations, whereas other caddisfly taxa were represented by no more than three individuals at each site. Taxa sensitive to organic pollutants that were present in downstream stations in the spring tended to decrease in abundance in upstream stations. The mayfly *Acerpenna*, for example, was very abundant at Station 1, but declined considerably at Stations 2 and 3

and was almost absent at Stations 4 and 5. At the same time, *Caenis latipennis* (a species more tolerant of organic pollution) was very rare at Station 1, but was the dominant mayfly taxon at the remaining stations. Other tolerant taxa that were more abundant among the upstream three stations included aquatic worms (Tubificidae) and the crustacean *Hyalella azteca*. This shift, in which certain sensitive species declined as tolerant species became more abundant in upstream stations, is likely the determining factor in the lower Biotic Index scores.

It was interesting to note the difference in mollusk abundance and diversity among seasons. Although macroinvertebrate data from other bioassessment studies demonstrate a similar trend (i.e., that mollusks tend to be less abundant in spring samples), the seasonal differences observed in Flat Creek samples were more pronounced. One possible explanation for this difference may result from the seasonal migratory habits of mollusks in which they burrow deep into the stream bed or embed themselves along the stream bank during winter, which would make them less susceptible to capture using our sampling techniques. Another possibility is that scouring flows resulting from stormwater during the winter months between sampling seasons were sufficient to dislodge mollusks occurring in rootmat (typically, the habitat in which the majority of mollusks are collected). This explanation, although possible, is less likely given that there were no unusually heavy precipitation events that occurred within the watershed between sample seasons.

Overall, the macroinvertebrate community composition of Flat Creek corresponded well with biocriteria reference streams. One exception was that stoneflies consistently made up a lower percentage of spring samples in Flat Creek compared to the reference streams. In addition, EPT Taxa scores tended to be lower among all but Station 2 compared to reference streams. Despite these factors, Flat Creek Stream Condition Index scores were at least comparable to some of the lower scores among reference streams and, in the case of Stations 1 and 2, scored very similarly to the reference sites.

7.0 Conclusions

The macroinvertebrate assemblage and related scoring metrics as well as some of the water quality parameters tested tended to change in response to physical differences observed within the Flat Creek survey reach. The upstream three sites tended to be smaller and have considerably lower flows compared to Station 1 and Station 2. Particularly, Station 4 and Station 5 had a fraction of the flow present at the lower three sites. Presumably, these sites could experience water quality issues such as increased temperatures and lower dissolved oxygen concentrations that would not be conducive to maintaining a community that includes sensitive macroinvertebrates. Despite the large difference in flow rate between upstream and downstream sites, few differences were observed in water quality parameters among sites during fall sampling. During spring, however, temperature and conductivity were higher at Station 4 and Station 5 compared to the downstream sites. Station 5 had the highest chloride and conductivity readings in the spring. This site was adjacent to a crop field on which poultry litter had been applied

and was downstream from a small cattle feedlot located on a family farm. Although Station 3 was located downstream from the confluence of a stream receiving wastewater discharge, it did not exhibit any changes in the water quality parameters we tested. The upstream three sites, which had varying but mostly minimal water quality trends, exhibited some macroinvertebrate trends indicative of declining water quality including a shift toward more tolerant taxa and decline of certain intolerant taxa in upstream stations. These trends at least partly explain the upstream three stations having lower SCI scores than the downstream stations. Two study sites, Station 3 and Station 4, failed to score a sufficiently high SCI score in fall 2004 to achieve fully supporting status. Station 3, however, would have had an SCI score sufficient to score fully supporting had there been a single additional taxon to supplement the Taxa Richness metric. Among spring samples, each of the three upstream sites--Stations 3, 4, and 5--failed to achieve fully supporting status.

The downstream two sites had much higher flow rates than the upper sites during both sample seasons. Higher flow rates and the resulting additional habitat available for macroinvertebrate use may have contributed to the higher SCI scores observed at the downstream stations. In addition, this higher volume of water flowing over riffle habitat would provide better oxygenation, a limiting factor among some sensitive macroinvertebrate taxa groups. Taxa that tend to be more sensitive, including mayfly, stonefly, and caddisflies, tended to be more diverse and abundant in the downstream stations, particularly in the spring season. Although the downstream stations receive stormwater runoff from the city of Sedalia, it is apparent that this runoff is either of insufficient quantity or is not degraded severely enough to have an observable effect on the macroinvertebrate community.

8.0 Summary

1. Station 5 had the highest chloride and conductivity readings in the spring. This site was adjacent to a crop field, which is used for land application of poultry litter and downstream from a small cattle feedlot.

2. Flow was much lower at Station 4 and Station 5 than the remaining sites.

3. Station 3 was located downstream from the confluence from a wastewater treatment receiving stream, yet did not exhibit any changes in the water quality parameters we tested.

4. The lowest habitat assessment score occurred at Station 1, which was due mainly to poor riparian corridor and sparse vegetative cover along a sizeable portion of the banks within this sample reach. Despite a low score compared to the remaining sites, it was sufficient to assume that the site should, based on habitat availability and quality, support an aquatic community comparable to reference streams.

5. Macroinvertebrate taxa that are more tolerant of organic pollution, specifically the mayfly *Caenis latipennis* and the crustacean *Hyalella azteca,* tended to increase in abundance in upstream stations. Conversely, intolerant taxa such as the mayfly *Acerpenna* and the stonefly *Perlesta* were less common in upstream sites.

6. For reasons not fully understood, mollusks were rare or absent at all but Station 5 in spring samples.

7. Flat Creek macroinvertebrate data generally correspond with reference stream data with two exceptions: Flat Creek EPT Taxa values were generally lower than reference sites and stoneflies made up a lower percentage of Flat Creek spring samples than references.

9.0 Recommendations

1. Given the differences in flow rates and macroinvertebrate community scores, consider the downstream (Station 1 and Station 2) separately from the remaining upstream sites.

2. Due to fully supporting SCI scores and lack of apparent water quality problems during both sample seasons, remove the downstream reach of Flat Creek from the 303(d) list of impaired waters.

3. Conduct an additional biocriteria monitoring survey of the upstream three Flat Creek stations to determine whether the partially-supporting scores recorded in the present study can be duplicated.

10.0 References Cited

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Missouri Department of Natural Resources 2003b. Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure. MDNR Environmental Services Program. Jefferson City, Missouri. 24 pp.

Missouri Department of Natural Resources 2003c. Stream Habitat Assessment Project Procedure. MDNR Environmental Services Program. Jefferson City, Missouri. 40 pp.

Missouri Department of Natural Resources 2003d. Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations. MDNR Environmental Services Program. Jefferson City, Missouri. 21 pp.

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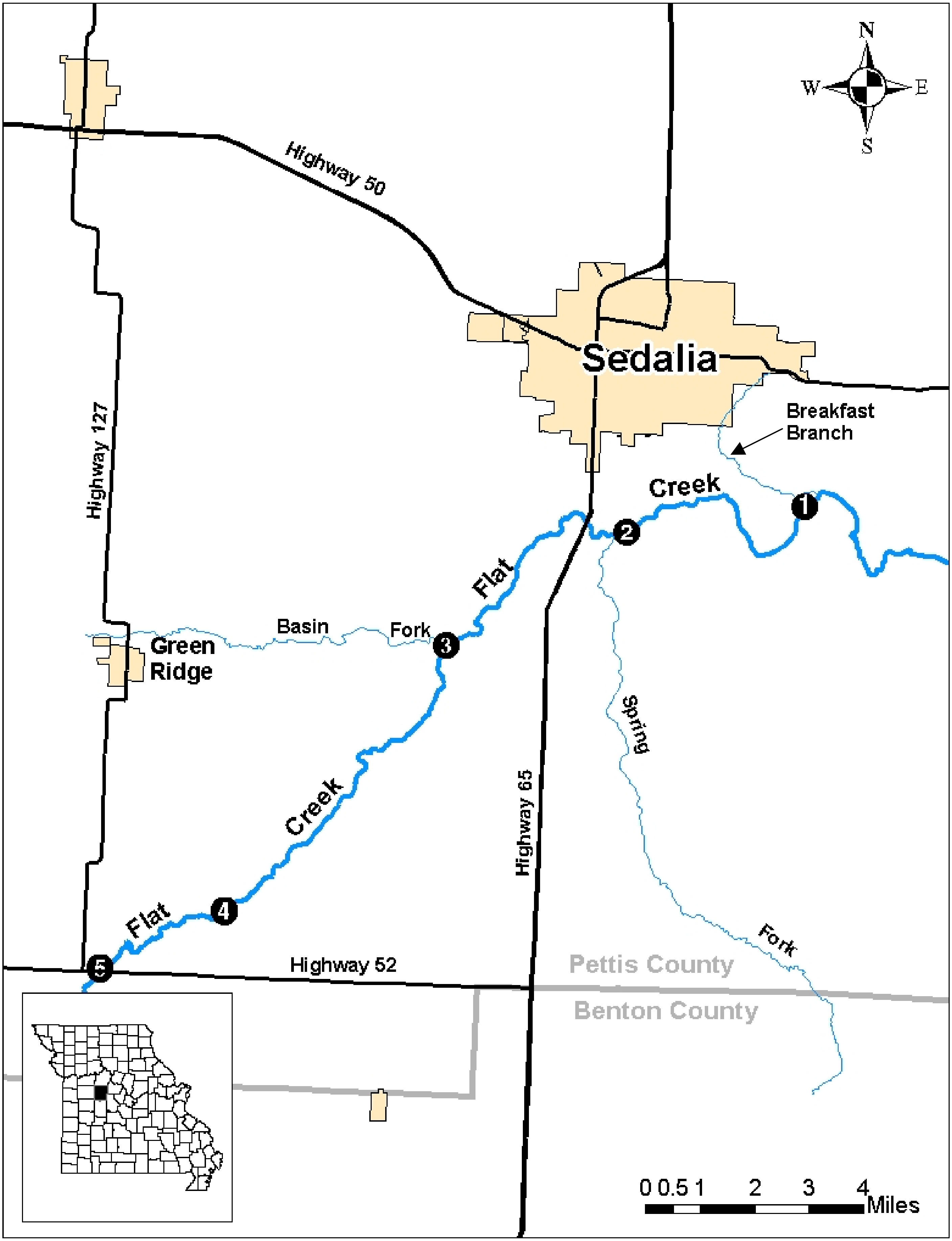
Appendix A

Maps

Flat Creek Sample Stations
Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU

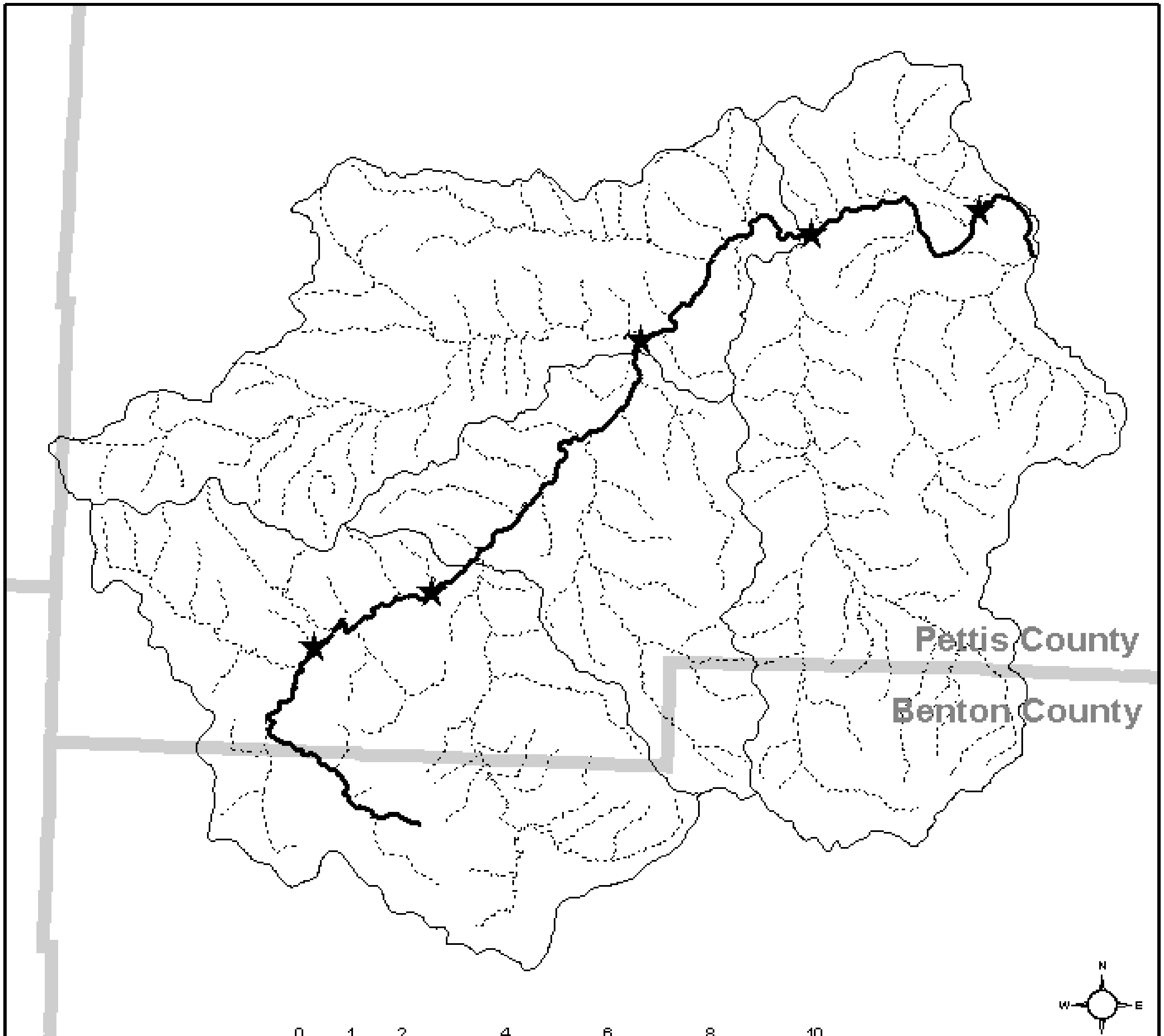
&

Flat Creek Study Area
Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU



N
W
E
S
Highway 50
Sedalia
Breakfast Branch
Creek
Flat
Highway 127
Basin
Fork
Green Ridge
Spring
Highway 65
Creek
Flat
Fork
Highway 52
Pettis County
Benton County
0 0.5 1 2 3 4 Miles

Flat Creek Study Site



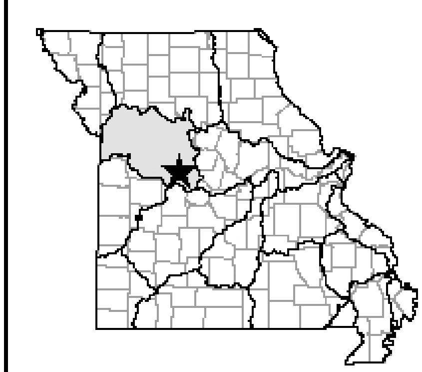
Local Drainage

★ Sampling Location
County Boundary
Local Drainage
Flat Creek

Local Drainage and Biologic Sampling Site Location

Ecolocial Drainage Unit (EDU) - An EDU is an area that contains a unique combination of habitats and organisms. Missouri is divided into 19 EDUs as shown in the inset map below. This site is located in the highlighted EDU.

Local Drainage - The local drainage area, also known as the 11 Digit Hydrologic Unit, is shown in the main map at left. This area includes the local watershed. Missouri is split into over 350 such units.


Ecological Drainage Unit

Appendix B

Flat Creek Macroinvertebrate Taxa Lists

Aquid Invertebrate Database Bench Sheet Report
Flat Ck [0418731], Station #1, Sample Date: 9/27/2004 11:45:00 AM
CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples

ORDER: TAXA	**CS**	**NF**	**RM**
"HYDRACARINA"			
Acarina		10	
AMPHIPODA			
Crangonyx			12
Hyalella azteca			60
ARHYNCHOBDELLIDA			
Erpobdellidae		1	-99
BRANCHIOBDELLIDA			
Branchiobdellida	1	1	
COLEOPTERA			
Berosus		5	3
Dubiraphia		3	4
Macronychus glabratus			2
Peltodytes		1	
Scirtes			1
Stenelmis	50		14
DECAPODA			
Orconectes luteus	2	-99	
Palaemonetes kadiakensis			-99
DIPTERA			
Ablabesmyia	1	3	
Ceratopogoninae		21	
Chaoborus		1	
Chironomus		19	
Cladopelma		1	
Cladotanytarsus		5	
Corynoneura		4	1
Cricotopus bicinctus	1		3
Cricotopus/Orthocladius			1
Cryptochironomus	1	2	
Cryptotendipes		1	
Dicrotendipes		1	2
Glyptotendipes		1	1
Hemerodromia	1		
Hexatoma	1		
Labrundinia		1	13
Nanocladius		3	3
Nilotanypus	2		
Parakiefferiella		2	
Paratanytarsus		4	5
Paratendipes		3	
Phaenopsectra		3	
Polypedilum convictum grp	50		7
Polypedilum fallax grp		1	
Polypedilum halterale grp		23	
Polypedilum illinoense grp	1	1	16
Procladius		3	
Pseudochironomus		1	
Rheotanytarsus	76		130

ORDER: TAXA	CS	NF	RM
Simulium	11	1	21
Stenochironomus		1	
Stictochironomus		1	
Tabanus	-99		
Tanytarsus	7	28	10
Thienemanniella			1
Thienemannimyia grp.	16		14
Tipula		2	
EPHEMEROPTERA			
Acerpenna	111	1	10
Baetis	141		1
Caenis latipennis	7	5	2
Isonychia	2		
Procloeon		1	
Stenacron	7		
Stenonema femoratum	5	7	1
Tricorythodes	1		6
HEMIPTERA			
Corixidae		4	
Mesovelia			1
Neoplea			1
LIMNOPHILA			
Ancylidae			1
Helisoma	-99	1	-99
Menetus			3
Physella			-99
MESOGASTROPODA			
Hydrobiidae		2	2
ODONATA			
Argia			4
Calopteryx			-99
Didymops		-99	
Enallagma			2
Hetaerina			7
Nasiaeschna pentacantha			-99
TRICHOPTERA			
Cheumatopsyche	154		16
Chimarra	55		2
Hydroptila	2		
Oxyethira	1		
TRICLADIDA			
Planariidae	3		7
TUBIFICIDA			
Limnodrilus cervix		1	
Limnodrilus hoffmeisteri		2	
Quistradrilus multisetosus		4	
Tubificidae		63	
VENEROIDEA			
Sphaeriidae	1		2

Aquid Invertebrate Database Bench Sheet Report
Flat Ck [0418732], Station #2, Sample Date: 9/27/2004 1:45:00 PM
CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina		24	3
AMPHIPODA			
Crangonyx			3
Hyalella azteca		1	117
COLEOPTERA			
Dubiraphia		2	2
Hydroporus		1	
Scirtes			8
Stenelmis	136	6	8
DECAPODA			
Orconectes luteus	-99		
Orconectes virilis			-99
Palaemonetes kadiakensis			-99
DIPTERA			
Ablabesmyia		15	4
Axarus		1	
Ceratopogoninae		2	
Chironomus		1	
Cladotanytarsus		3	
Corynoneura		1	
Cricotopus/Orthocladius	2		2
Cryptochironomus		7	
Cryptotendipes		1	
Dicrotendipes		1	1
Glyptotendipes		1	17
Hexatoma	1		
Labrundinia		1	8
Microtendipes		1	
Nanocladius		1	4
Parachironomus		1	2
Paratanytarsus		2	11
Polypedilum	1		
Polypedilum convictum grp	54		
Polypedilum fallax grp			1
Polypedilum illinoense grp	1		1
Procladius		5	
Pseudochironomus		1	
Rheotanytarsus	139	2	6
Simulium	16		
Stempellinella		2	
Stictochironomus		6	
Tabanus	-99		
Tanytarsus	5	14	6
Thienemanniella	4		
Thienemannimyia grp.	15		11
EPHEMEROPTERA			
Acerpenna	31		
Apobaetis		2	

ORDER: TAXA	CS	NF	RM
Baetis	57		
Caenis latipennis	3	97	8
Callibaetis		1	
Hexagenia limbata		2	
Leptophlebiidae		2	
Procloeon		1	
Stenacron	12	29	
Stenonema femoratum	13	56	1
Tricorythodes	1		
LUMBRICINA			
Lumbricidae	-99		
MEGALOPTERA			
Corydalus	-99		
ODONATA			
Argia	1	2	7
Enallagma			17
Macromia		1	
Nasiaeschna pentacantha			1
PLECOPTERA			
Isoperla	1		
RHYNCHOBDELLIDA			
Glossiphoniidae	-99		
TRICHOPTERA			
Cheumatopsyche	239	1	1
Chimarra	2		
Hydropsyche	3		
Hydroptila		1	1
Oecetis		2	1
TRICLADIDA			
Planariidae	24		1
TUBIFICIDA			
Quistradrilus multisetosus		1	
Tubificidae	6	14	
VENEROIDEA			
Sphaeriidae	4	1	8

Aquid Invertebrate Database Bench Sheet Report
Flat Ck [0418732], Station #2, Sample Date: 9/27/2004 1:45:00 PM
CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples

Aquid Invertebrate Database Bench Sheet Report
Flat Ck [0418733], Station #3, Sample Date: 9/28/2004 9:45:00 AM
CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples

ORDER: TAXA	**CS**	**NF**	**RM**
"HYDRACARINA"			
Acarina		9	1
AMPHIPODA			
Hyalella azteca		2	190
ARHYNCHOBDELLIDA			
Erpobdellidae	-99	2	
COLEOPTERA			
Dubiraphia		1	8
Hydroporus		2	
Scirtes			1
Stenelmis	108	2	6
DECAPODA			
Orconectes luteus	-99	-99	-99
Orconectes virilis		-99	-99
Palaemonetes kadiakensis			-99
DIPTERA			
Ablabesmyia	3	10	2
Ceratopogoninae		15	1
Chironomus		1	
Cladotanytarsus		2	
Corynoneura	1	1	1
Cricotopus/Orthocladius	6		1
Cryptochironomus	2	1	
Dicrotendipes		1	
Glyptotendipes		3	
Hemerodromia	1		
Hexatoma	10		
Microtendipes	1	2	
Nanocladius	1		1
Nilotanypus	16		
Paratanytarsus		6	15
Paratendipes		4	2
Phaenopsectra		1	
Polypedilum	3		
Polypedilum convictum grp	84		
Polypedilum halterale grp		2	
Polypedilum illinoense grp	2	1	
Polypedilum scalaenum grp		2	
Pseudochironomus		1	
Rheotanytarsus	17		
Simulium	2		1
Stictochironomus		3	
Tabanus	2		
Tanytarsus	10	23	2
Thienemanniella	2		
Thienemannimyia grp.	65	2	2
Tipula		-99	
Tipulidae	1		
EPHEMEROPTERA			

ORDER: TAXA	CS	NF	RM
Acerpenna	136		
Baetis	199		
Caenis latipennis	12	94	13
Callibaetis		1	2
Hexagenia limbata		-99	
Stenacron	58	6	
Stenonema femoratum	56	25	8
ISOPODA			
Lirceus			1
LIMNOPHILA			
Ancylidae		1	3
Menetus			3
Physella	-99		2
LUMBRICINA			
Lumbricidae	-99		
MEGALOPTERA			
Sialis	1	1	
ODONATA			
Argia	6	-99	3
Enallagma			17
Gomphus		-99	
RHYNCHOBDELLIDA			
Glossiphoniidae			1
TRICHOPTERA			
Cheumatopsyche	208		1
Chimarra	21		
Hydropsyche	1		
Oecetis		1	
TRICLADIDA			
Planariidae	2		1
TUBIFICIDA			
Branchiura sowerbyi		1	
Enchytraeidae		1	
Tubificidae	2	87	2
VENEROIDEA			
Sphaeriidae		1	2

Aquid Invertebrate Database Bench Sheet Report
Flat Ck [0418733], Station #3, Sample Date: 9/28/2004 9:45:00 AM
CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples

Aquid Invertebrate Database Bench Sheet Report
Flat Ck [0418734], Station #4, Sample Date: 9/28/2004 1:00:00 PM
CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples

ORDER: TAXA	**CS**	**NF**	**RM**
"HYDRACARINA"			
Acarina		7	
AMPHIPODA			
Hyalella azteca	1		145
ARHYNCHOBDELLIDA			
Erpobdellidae	1		
COLEOPTERA			
Berosus			2
Hydroporus		2	4
Scirtes			11
Stenelmis	163	10	5
DECAPODA			
Orconectes virilis			-99
DIPTERA			
Ablabesmyia	3	5	1
Ceratopogoninae	1	22	
Chironomus		6	
Corynoneura		1	1
Cricotopus/Orthocladius	4		
Cryptochironomus	1	2	
Forcipomyiinae	2		1
Glyptotendipes		6	15
Kiefferulus		3	
Labrundinia	1		2
Microtendipes	2	20	1
Nanocladius			2
Nilotanypus	3		
Parachironomus			1
Paratanytarsus		3	23
Paratendipes		3	
Polypedilum convictum grp	78	1	1
Polypedilum halterale grp		6	
Polypedilum illinoense grp	9		5
Polypedilum scalaenum grp	4	2	
Procladius		9	
Pseudochironomus		1	
Rheotanytarsus	2		1
Simulium	1		
Stenochironomus			1
Stictochironomus		2	
Tabanus	1		
Tanytarsus	16	13	4
Thienemanniella		1	1
Thienemannimyia grp.	43		3
Tribelos		2	
EPHEMEROPTERA			
Acerpenna	21		1
Baetis	41		
Caenis latipennis	18	79	11

ORDER: TAXA	CS	NF	RM
Callibaetis			1
Choroterpes		1	
Hexagenia limbata		1	
Stenacron	5	5	
Stenonema femoratum	60	51	5
HEMIPTERA			
Corixidae		1	
ISOPODA			
Caecidotea (Blind & Unpigmented)	1		
LIMNOPHILA			
Ancylidae		4	
Menetus			1
LUMBRICULIDA			
Lumbriculidae			1
MEGALOPTERA			
Sialis		-99	
ODONATA			
Enallagma			6
Tetragoneuria			1
RHYNCHOBDELLIDA			
Glossiphoniidae	2	2	1
TRICHOPTERA			
Cheumatopsyche	202	1	
Chimarra	38	1	
TRICLADIDA			
Planariidae			8
TUBIFICIDA			
Branchiura sowerbyi		11	
Tubificidae	29	83	
VENEROIDEA			
Sphaeriidae	1	1	

Aquid Invertebrate Database Bench Sheet Report
Flat Ck [0418734], Station #4, Sample Date: 9/28/2004 1:00:00 PM
CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples

Aquid Invertebrate Database Bench Sheet Report
Flat Ck [0418736], Station #5, Sample Date: 9/29/2004 9:45:00 AM
CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples

ORDER: TAXA	**CS**	**NF**	**RM**
"HYDRACARINA"			
Acarina		1	11
AMPHIPODA			
Hyalella azteca			210
ARHYNCHOBDELLIDA			
Erpobdellidae	4	5	
COLEOPTERA			
Berosus	1		1
Coleoptera	1		
Dubiraphia		1	3
Hydroporus	1	2	1
Scirtes			19
Stenelmis	332	10	
Tropisternus			1
DECAPODA			
Orconectes virilis		-99	-99
DIPTERA			
Ablabesmyia	1	5	4
Anopheles			1
Ceratopogonidae		2	
Chironomus		3	
Corynoneura	5		
Cricotopus/Orthocladius	11	1	
Cryptochironomus		2	
Dicrotendipes	4	3	3
Forcipomyiinae	1		
Glyptotendipes	1		9
Hemerodromia	3		
Kiefferulus			1
Labrundinia	1		1
Microtendipes	6		
Nanocladius	3		4
Nilotanypus	2		
Parachironomus			1
Paratanytarsus	3	4	34
Paratendipes	4	2	
Polypedilum convictum grp	33		
Polypedilum halterale grp		1	
Polypedilum illinoense grp	22	7	1
Polypedilum scalaenum grp	20		1
Procladius		2	
Rheotanytarsus	1		
Simulium	3		
Tabanus	-99		
Tanytarsus	16	1	5
Thienemanniella	4		
Thienemannimyia grp.	10		2
EPHEMEROPTERA			
Acerpenna	5		

ORDER: TAXA	CS	NF	RM
Baetis	70		
Caenis latipennis	216	166	47
Callibaetis			1
Heptageniidae	14	11	
Leptophlebiidae			1
Stenacron	1	1	
Stenonema femoratum	72	42	8
HEMIPTERA			
Belostoma			-99
Corixidae		1	
Neoplea			4
LIMNOPHILA			
Helisoma	-99		-99
Laevapex	1		
Menetus			82
Physella	2	-99	15
MEGALOPTERA			
Sialis		1	
ODONATA			
Argia	6		
Enallagma			22
Epicordulia			-99
RHYNCHOBDELLIDA			
Glossiphoniidae	5		17
TRICHOPTERA			
Cheumatopsyche	81		
Chimarra	13		
TRICLADIDA			
Planariidae			17
TUBIFICIDA			
Aulodrilus		3	1
Branchiura sowerbyi		4	
Limnodrilus hoffmeisteri	3		
Tubificidae	30	16	2
VENEROIDEA			
Sphaeriidae	1	5	2

Aquid Invertebrate Database Bench Sheet Report
Flat Ck [0418736], Station #5, Sample Date: 9/29/2004 9:45:00 AM
CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples

Aquid Invertebrate Database Bench Sheet Report
Flat Ck [0503014], Station #1, Sample Date: 3/28/2005 10:30:00 AM
CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples

ORDER: TAXA	**CS**	**NF**	**RM**
"HYDRACARINA"			
Acarina		2	
AMPHIPODA			
Crangonyx	2		2
Hyalella azteca			4
Stygobromus		1	
ARHYNCHOBDELLIDA			
Erpobdellidae		1	-99
COLEOPTERA			
Dubiraphia			1
Stenelmis	137	15	8
DECAPODA			
Orconectes virilis			-99
Palaemonetes kadiakensis			-99
DIPTERA			
Ablabesmyia		14	
Ceratopogoninae		7	
Cladotanytarsus	1	10	
Corynoneura	16	3	
Cricotopus bicinctus	1		
Cricotopus/Orthocladius	21	2	12
Cryptochironomus	9	13	
Dicrotendipes		1	
Eukiefferiella	3		
Glyptotendipes			2
Hexatoma		1	
Hydrobaenus		5	1
Larsia	5	4	
Nanocladius		1	3
Nilotanypus			2
Orthocladius (Euorthocladius)	1		
Parakiefferiella	1		
Parametriocnemus	2		
Paratanytarsus			44
Paratendipes	6	68	1
Polypedilum convictum grp	52	2	4
Polypedilum halterale grp		4	
Polypedilum illinoense grp	4	2	10
Polypedilum scalaenum grp	9	20	
Pseudochironomus	1		
Rheotanytarsus	11	2	111
Simulium	13		8
Stictochironomus		6	
Tanytarsus	5	16	23
Thienemannimyia grp.	69	2	27
Tvetenia	1		
EPHEMEROPTERA			
Acentrella	1		
Acerpenna	118	2	40

ORDER: TAXA	**CS**	**NF**	**RM**
Caenis latipennis	4	16	17
Leptophlebia			-99
Leptophlebiidae	2		
Stenacron	24	4	4
Stenonema femoratum	24	2	1
HEMIPTERA			
Ranatra nigra			-99
ISOPODA			
Caecidotea (Blind & Unpigmented)	6	3	
LUMBRICINA			
Lumbricidae		1	
LUMBRICULIDA			
Lumbriculidae	6	4	
ODONATA			
Enallagma			1
Hetaerina			1
PLECOPTERA			
Amphinemura			1
Chloroperlidae	1		
Isoperla	7		-99
Perlesta	35	1	4
RHYNCHOBDELLIDA			
Glossiphoniidae	1		
TRICHOPTERA			
Cheumatopsyche	1		4
Chimarra			1
Oecetis			1
TRICLADIDA			
Planariidae	1		1
TUBIFICIDA			
Enchytraeidae	1		
Ilyodrilus templetoni		1	
Limnodrilus claparedianus		1	
Limnodrilus hoffmeisteri		7	1
Quistradrilus multisetosus		1	
Tubificidae	3	14	2
VENEROIDEA			
Sphaeriidae			-99

Aquid Invertebrate Database Bench Sheet Report
Flat Ck [0503016], Station #2, Sample Date: 3/28/2005 12:30:00 PM
CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina		10	
AMPHIPODA			
Hyalella azteca			11
ARHYNCHOBDELLIDA			
Erpobdellidae	-99		
COLEOPTERA			
Berosus			-99
Hydroporus			2
Scirtes			1
Stenelmis	162	13	11
DECAPODA			
Orconectes virilis			-99
Palaemonetes kadiakensis			-99
DIPTERA			
Ablabesmyia		8	1
Ceratopogoninae		6	
Corynoneura			1
Cricotopus bicinctus	1		
Cricotopus/Orthocladius	80	6	31
Cryptochironomus	3	8	
Dicrotendipes		4	2
Eukiefferiella	8		
Glyptotendipes			1
Hemerodromia			1
Hexatoma	2		
Hydrobaenus		8	5
Larsia	1	1	1
Nanocladius		2	6
Nilotanypus			1
Parametriocnemus	4		1
Paratanytarsus		2	14
Paratendipes		57	
Polypedilum convictum grp	30	2	
Polypedilum illinoense grp	2	2	17
Polypedilum scalaenum grp	7	16	
Rheotanytarsus	15	3	25
Simulium	18		1
Stictochironomus		1	
Tabanus	-99		
Tanytarsus	16	36	30
Thienemannimyia grp.	24	1	24
Tvetenia	1		
EPHEMEROPTERA			
Acentrella	3		
Acerpenna	45		19
Caenis latipennis	12	33	79
Heptagenia	1	1	
Leptophlebiidae	1	1	

ORDER: TAXA	CS	NF	RM
Stenacron	29	2	1
Stenonema femoratum	73	15	14
HEMIPTERA			
Belostoma			-99
ODONATA			
Argia			2
Basiaeschna janata			-99
Enallagma			13
Hetaerina			1
PLECOPTERA			
Amphinemura	1		
Isoperla	17		
Neoperla	1		
Perlesta	18		
RHYNCHOBDELLIDA			
Glossiphoniidae		1	
TRICHOPTERA			
Cheumatopsyche	4		1
Chimarra	1		
Cyrnellus fraternus	1		
Ironoquia			-99
Oecetis			2
TRICLADIDA			
Planariidae	4		
TUBIFICIDA			
Aulodrilus		1	
Ilyodrilus templetoni		1	
Limnodrilus cervix		2	
Limnodrilus hoffmeisteri	2	4	
Tubificidae	6	9	

CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples

Aquid Invertebrate Database Bench Sheet Report
Flat Ck [0503017], Station #3, Sample Date: 3/29/2005 10:30:00 AM
CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina		1	3
AMPHIPODA			
Hyalella azteca			54
ARHYNCHOBDELLIDA			
Erpobdellidae	1		-99
BRANCHIOBDELLIDA			
Branchiobdellida			1
COLEOPTERA			
Berosus		1	1
Dubiraphia			1
Hydroporus			2
Stenelmis	122	13	3
DECAPODA			
Orconectes luteus	-99		-99
Orconectes virilis			-99
DIPTERA			
Ablabesmyia	1	7	1
Ceratopogoninae	1	1	
Cladotanytarsus		9	
Corynoneura	7		
Cricotopus/Orthocladius	127	5	20
Cryptochironomus	4	17	
Dicrotendipes		1	1
Eukiefferiella	8		
Hexatoma	-99		
Hydrobaenus	8	16	2
Larsia	2	1	1
Nanocladius	1		5
Nilotanypus	7		
Nilothauma			1
Orthocladius (Euorthocladius)	1		
Parametriocnemus	5		
Paratanytarsus			25
Paratendipes	4	64	
Polypedilum convictum grp	56		2
Polypedilum halterale grp		1	
Polypedilum illinoense grp	2		4
Polypedilum scalaenum grp	17	20	1
Pseudochironomus		1	
Rheotanytarsus			6
Simulium	11		
Stictochironomus		9	
Tabanus	-99		
Tanytarsus	5	7	20
Thienemannimyia grp.	59	3	15
EPHEMEROPTERA			
Acentrella	1		
Acerpenna	59	1	

ORDER: TAXA	CS	NF	RM
Caenis latipennis	18	19	113
Leptophlebiidae	3	1	
Stenacron	4		
Stenonema femoratum	81	3	
ISOPODA			
Lirceus			1
LIMNOPHILA			
Ancylidae			5
ODONATA			
Argia			1
Enallagma			6
PLECOPTERA			
Isoperla	11		
Perlesta	32		1
TRICHOPTERA			
Cheumatopsyche	1		
Oecetis			1
TUBIFICIDA			
Limnodrilus cervix		14	
Limnodrilus hoffmeisteri	1	14	
Tubificidae	8	66	
VENEROIDEA			
Sphaeriidae	2		5

Aquid Invertebrate Database Bench Sheet Report
Flat Ck [0503017], Station #3, Sample Date: 3/29/2005 10:30:00 AM
CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples

Aquid Invertebrate Database Bench Sheet Report
Flat Ck [0503018], Station #4, Sample Date: 3/29/2005 12:00:00 PM
CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples

ORDER: TAXA	**CS**	**NF**	**RM**
AMPHIPODA			
Hyalella azteca			94
ARHYNCHOBDELLIDA			
Erpobdellidae	-99	-99	
BRANCHIOBDELLIDA			
Branchiobdellida			1
COLEOPTERA			
Berosus		2	1
Scirtes			3
Stenelmis	84	11	3
DECAPODA			
Orconectes virilis	-99		1
DIPTERA			
Ablabesmyia	9	22	2
Ceratopogoninae	1	4	
Chironomus		1	
Cladotanytarsus		1	
Corynoneura	26		
Cricotopus bicinctus			1
Cricotopus/Orthocladius	31	5	18
Cryptochironomus	4	11	
Diamesa	3		
Dicrotendipes		1	6
Eukiefferiella	2		
Glyptotendipes			4
Hemerodromia	1		
Hydrobaenus	1	5	5
Larsia	1		
Nanocladius			6
Natarsia		4	
Nilotanypus	3		
Parakiefferiella	1		2
Paratanytarsus	1	4	62
Paratendipes	7	26	
Phaenopsectra			1
Pilaria		1	
Polypedilum convictum grp	169		2
Polypedilum halterale grp		4	
Polypedilum illinoense grp	1	2	5
Polypedilum scalaenum grp	88	5	
Procladius		3	
Pseudochironomus	1		
Rheotanytarsus	3		1
Simulium	14		
Stictochironomus		7	
Tabanus	2		
Tanytarsus	15	15	20
Thienemanniella		1	
Thienemannimyia grp.	32	2	14

ORDER: TAXA	CS	NF	RM
EPHEMEROPTERA			
Acerpenna	2		
Caenis latipennis	9	48	41
Heptageniidae	10		
Leptophlebiidae	2		
Stenonema femoratum	13	26	10
HEMIPTERA			
Ranatra kirkaldyi			1
LIMNOPHILA			
Fossaria		-99	
LUMBRICULIDA			
Lumbriculidae		1	
ODONATA			
Enallagma			9
Nasiaeschna pentacantha			-99
PLECOPTERA			
Isoperla	-99		
Perlesta	19		
RHYNCHOBDELLIDA			
Glossiphoniidae		-99	
TRICHOPTERA			
Cheumatopsyche	-99		
Chimarra	5		
Ptilostomis			-99
TRICLADIDA			
Planariidae			5
TUBIFICIDA			
Aulodrilus		1	
Branchiura sowerbyi		3	
Enchytraeidae	1	1	
Ilyodrilus templetoni		1	
Limnodrilus cervix		16	
Limnodrilus hoffmeisteri	3	3	
Tubificidae	4	45	

Aquid Invertebrate Database Bench Sheet Report
Flat Ck [0503018], Station #4, Sample Date: 3/29/2005 12:00:00 PM
CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples

Aquid Invertebrate Database Bench Sheet Report
Flat Ck [0503019], Station #5, Sample Date: 3/29/2005 1:15:00 PM
CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples

ORDER: TAXA	**CS**	**NF**	**RM**
"HYDRACARINA"			
Acarina		2	7
AMPHIPODA			
Hyalella azteca		2	74
ARHYNCHOBDELLIDA			
Erpobdellidae	-99	1	-99
BRANCHIOBDELLIDA			
Branchiobdellida			2
COLEOPTERA			
Hydroporus			1
Stenelmis	148	14	5
DIPTERA			
Ablabesmyia		5	2
Ceratopogoninae		30	
Cladopelma		1	
Cladotanytarsus		2	
Clinocera	1		
Cricotopus/Orthocladius	82	14	7
Cryptochironomus		2	
Diamesa	3		
Dicrotendipes	1	1	3
Glyptotendipes			7
Hydrobaenus	23	35	12
Nanocladius	1		2
Nilotanypus	5		
Parametriocnemus	1		
Paratanytarsus	1	1	79
Paratendipes	3	11	1
Polypedilum convictum grp	197	2	3
Polypedilum illinoense grp	26		10
Polypedilum scalaenum grp	22	23	4
Procladius		2	
Rheotanytarsus			5
Simulium	23		
Stenochironomus			1
Tanytarsus	10	12	12
Thienemanniella	1	1	5
Thienemannimyia grp.	14	2	6
EPHEMEROPTERA			
Acerpenna	3		
Caenis latipennis	5	29	40
Stenacron		5	
Stenonema femoratum	3	7	5
LIMNOPHILA			
Helisoma		1	-99
Menetus			9
Physella		-99	1
ODONATA			
Basiaeschna janata			1

ORDER: TAXA	CS	NF	RM
Enallagma			6
Epicordulia		-99	
Gomphus		-99	
Ischnura			3
Nasiaeschna pentacantha			-99
PLECOPTERA			
Perlesta	5		
RHYNCHOBDELLIDA			
Glossiphoniidae		-99	1
TRICHOPTERA			
Cheumatopsyche	5		
Ironoquia	1		
TRICLADIDA			
Planariidae			6
TUBIFICIDA			
Branchiura sowerbyi		4	
Enchytraeidae		1	
Ilyodrilus templetoni		1	
Limnodrilus cervix		5	
Limnodrilus claparedianus		1	
Limnodrilus hoffmeisteri	1	16	
Tubificidae	4	83	8
VENEROIDEA			
Sphaeriidae	2	-99	1

Aquid Invertebrate Database Bench Sheet Report
Flat Ck [0503019], Station #5, Sample Date: 3/29/2005 1:15:00 PM
CS = Coarse Substrate; NF = Non Flow; RM = Rootmat; -99 = Present in samples